Vee Antenna With Vertical Tails

A multiband antenna with low-angle radiation for the low bands.

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As we languish in the minimum in solar sunspot cycle, the major part of high-frequency communications is going to be carried out in the 30, 40, and 80 meter bands for the next couple of years. Horizontally polarized antennas for these bands have to be installed in excess of 50 feet in height to obtain the low angle of radiation necessary for DX work. Vertically polarized antennas, such as a quarter-wave ground-plane, are excellent for transmitting but poor for receiving on the low bands. Moreover, an excellent ground is required for ground-plane antennas to work well. If you are limited in the height of the antenna, then obtaining low angle radiation on the low bands becomes quite difficult.

Vee-with-tails design

A design that overcomes some of these limitations is the vee antenna modified to include vertical tails. The vee is an excellent multiband antenna in which two equal lengths of wire are formed in a vee configuration and fed with parallel-line tuned feeders at the apex of the vee. At low frequencies, the horizontal wires have to be fairly high in order to provide a low angle of radiation on the low bands.

In my design, the vee-beam antenna wire has vertical tails added at each end, reaching almost to the ground. These two vertical radiators behave like two 180° out-of-phase verticals fed at the top with current maximums above the ground. The horizontal wires of the vee antenna provide medium range reception, while the vertical tails provide the low angle of radiation necessary for DX. At high frequencies, the vee horizontal wires provide excellent gain and directivity.

Computer simulations of the vee-with-tails

Several different antenna designs with varying heights and lengths were simulated using the AO antenna simulation program. A wide range of lengths for the vee-with-tails were designed, based on the size of the lot available for placing the antenna. Some of these designs are listed in **Table 1**.

The longer the horizontal wire, the more the gain at high frequencies. However, the height of the antenna becomes critical at anything over 45 feet because long vertical wires tend to radiate at high angles when their lengths become longer than one-half wavelength at the operating frequency. This basically relegates the design of the multiband vee beam with tails to antennas approximately 35 to 45 feet high. However, a design of this antenna optimized for the 80 meter band would benefit from longer vertical wires, higher antenna height, and a larger included angle between the wires. The ideal length of the vertical wires was found to be one half the wavelength at the operating frequency, though shorter lengths also work well.

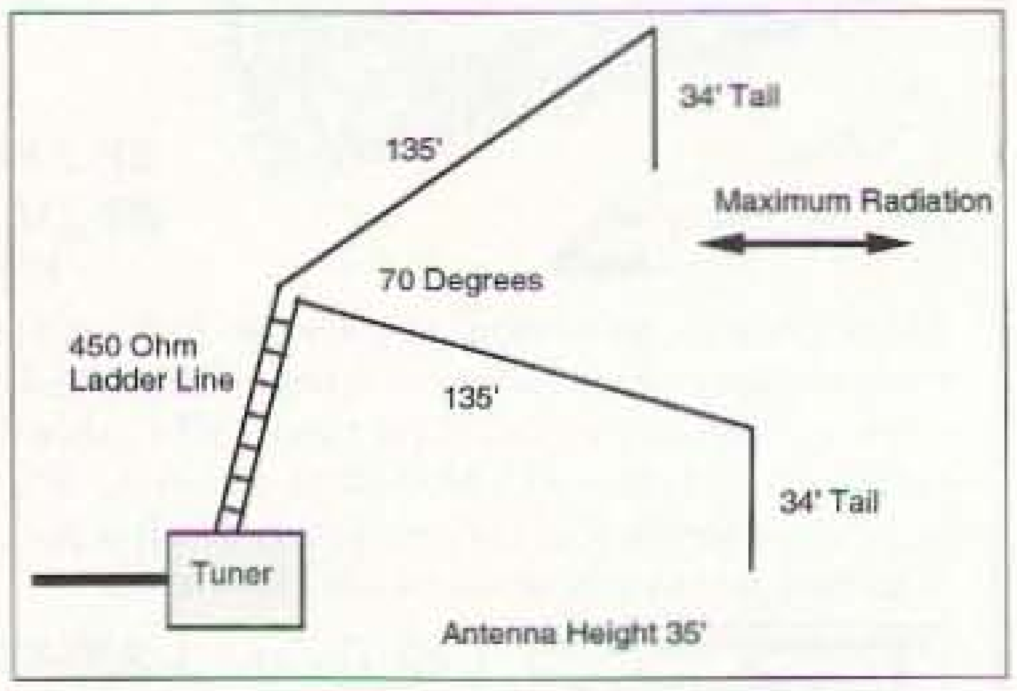


***Fig. 1** The horizontal wires are 135 feet long and are formed into a vee with an included angle of 70°. Vertical tails, each 34 feet long, are added at both ends to provide the low angle of radiation from the two top-fed, out-of-phase vertical radiators. The antenna is fed with parallel wire feeders, such as 450 ohm ladder line, and matched to the transmitter with a tuner or a 9 to 1 balun. Alternatively, it can be matched with a 9 to 1 or 16 to 1 balun at the feed point and fed with coax. Different lengths and sizes of the vee-with-tails designs are shown in **Table 1**.*

Test antenna

I built a test antenna with 135-foot horizontal components and 34-foot vertical tails, as shown in **Fig. 1**. The total height of the antenna was 35 feet, with an included

Type of Antenna	Leg Length (ft.)	Vee Angle (Deg.)	Tail Length (ft.)
Author's Test Antenna	135	70	34
G5RV Vee with Tails	51	120	24 or 34
Short Vee with Tails	82	100	34
80 Meter Dipole	67	180	24

***Table 1**. Some variations of the antenna designs that I've simulated on my computer. All antennas were simulated at a height of 35 feet. The length of the vertical tails can be decreased to 24 feet if necessary.*

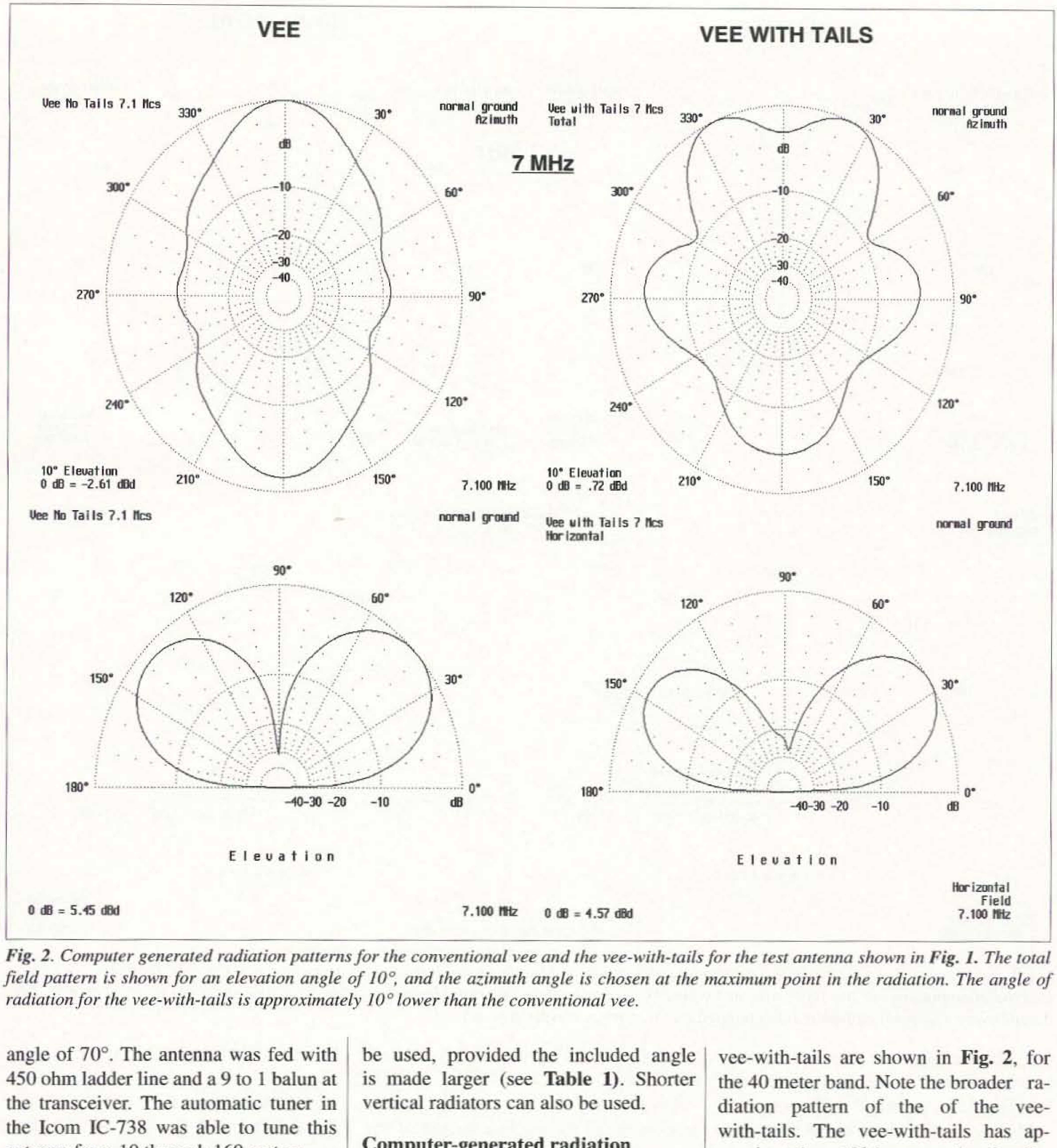


*Fig. 2. Computer generated radiation patterns for the conventional vee and the vee-with-tails for the test antenna shown in **Fig. 1**. The total field pattern is shown for an elevation angle of 10°, and the azimuth angle is chosen at the maximum point in the radiation. The angle of radiation for the vee-with-tails is approximately 10° lower than the conventional vee.*

angle of 70°. The antenna was fed with 450 ohm ladder line and a 9 to 1 balun at the transceiver. The automatic tuner in the Icom IC-738 was able to tune this antenna from 10 through 160 meters.

Final trimming of the SWR was carried out by trimming the length of each vertical wire equally. If a tuner is used between the transmitter and the 450 ohm ladder line, the length of the vee is not critical. Shorter horizontal lengths can be used, provided the included angle is made larger (see **Table 1**). Shorter vertical radiators can also be used.

Computer-generated radiation patterns for the test antenna

The test antenna design was optimized for the 30 meter band so it would work well from 80 to 10 meters. Computer-generated field-strength patterns comparing the horizontal vee and the vee-with-tails are shown in **Fig. 2**, for the 40 meter band. Note the broader radiation pattern of the of the vee-with-tails. The vee-with-tails has approximately a 10° lower angle of radiation due to the tails. The vertical radiation is compared to a simple ground-plane antenna in **Fig. 3,** which also shows the horizontal pattern. Note that two major lobes are formed for the vertical radiation. These combine with the horizontal radiation to provide a wide angle of coverage in the direction of the vee on 40 meters.

"I built and tested this antenna in one afternoon with the help of my 10-year-old son."

At high frequencies, the vertical wires radiate at high angles; however,

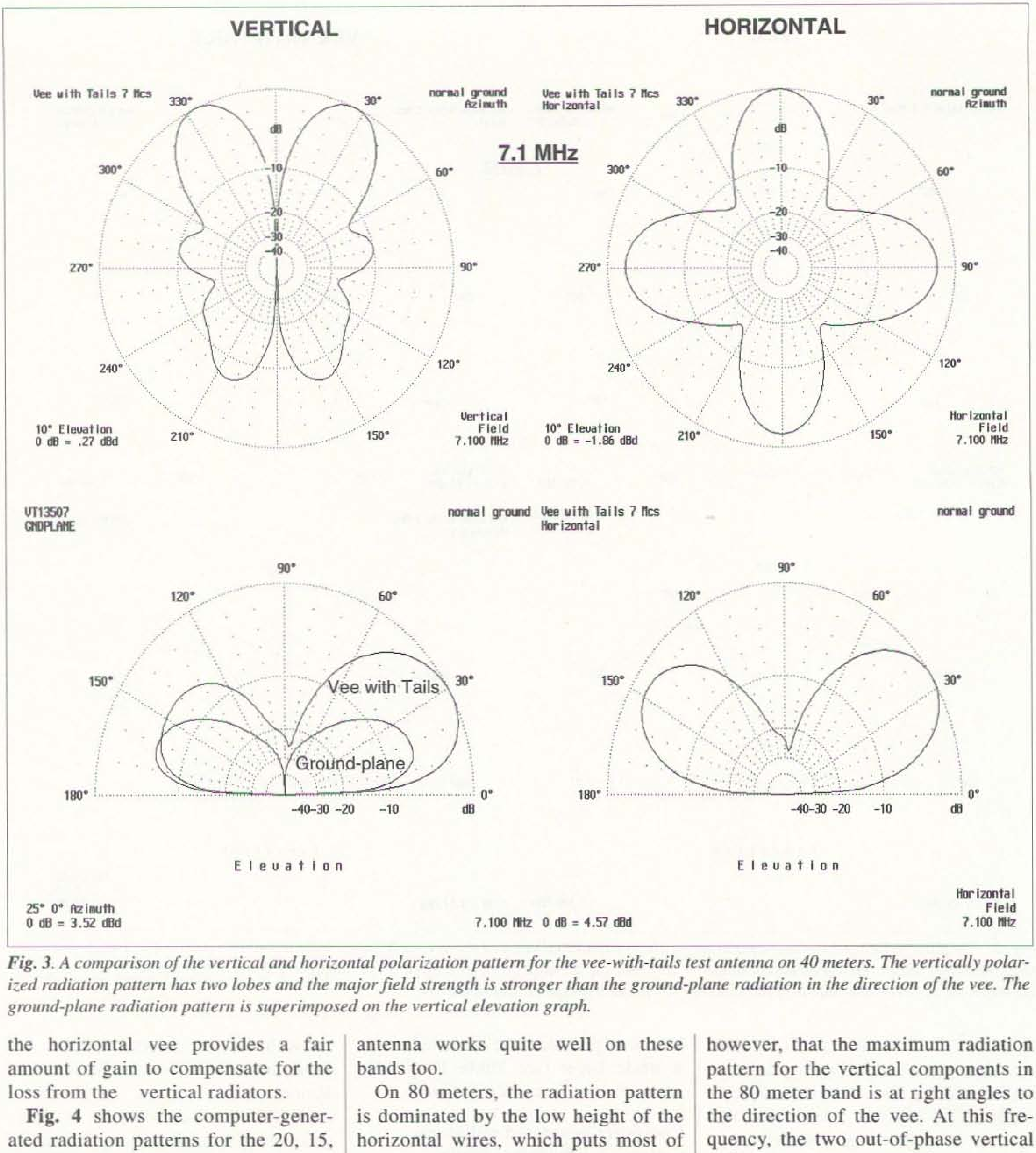


Fig. 3. A comparison of the vertical and horizontal polarization pattern for the vee-with-tails test antenna on 40 meters. The vertically polarized radiation pattern has two lobes and the major field strength is stronger than the ground-plane radiation in the direction of the vee. The ground-plane radiation pattern is superimposed on the vertical elevation graph.

the horizontal vee provides a fair amount of gain to compensate for the loss from the vertical radiators.

Fig. 4 shows the computer-generated radiation patterns for the 20, 15, and 10 meter bands. The patterns are equivalent to a three-element beam at low heights. And, even though the 17 and 24 meter data are not shown, the antenna works quite well on these bands too.

On 80 meters, the radiation pattern is dominated by the low height of the horizontal wires, which puts most of the radiation at a high angle. However, even at this low height, some low angle of radiation takes place on 80 meters, as shown in **Fig. 5**. Note, however, that the maximum radiation pattern for the vertical components in the 80 meter band is at right angles to the direction of the vee. At this frequency, the two out-of-phase vertical radiators are separated by approximately one-half wavelength and the maximum radiation pattern is in line with the two vertical elements.

"I've had a lot of fun with this antenna, especially since it is concealed among my trees and the neighbors don't even know that it exists."

Test results for the vee-with-tails

The test antenna has been used for two winters and in several contests. It was tested against a quarter-wave trap vertical antenna with ground radials as a standard. In the optimum direction of

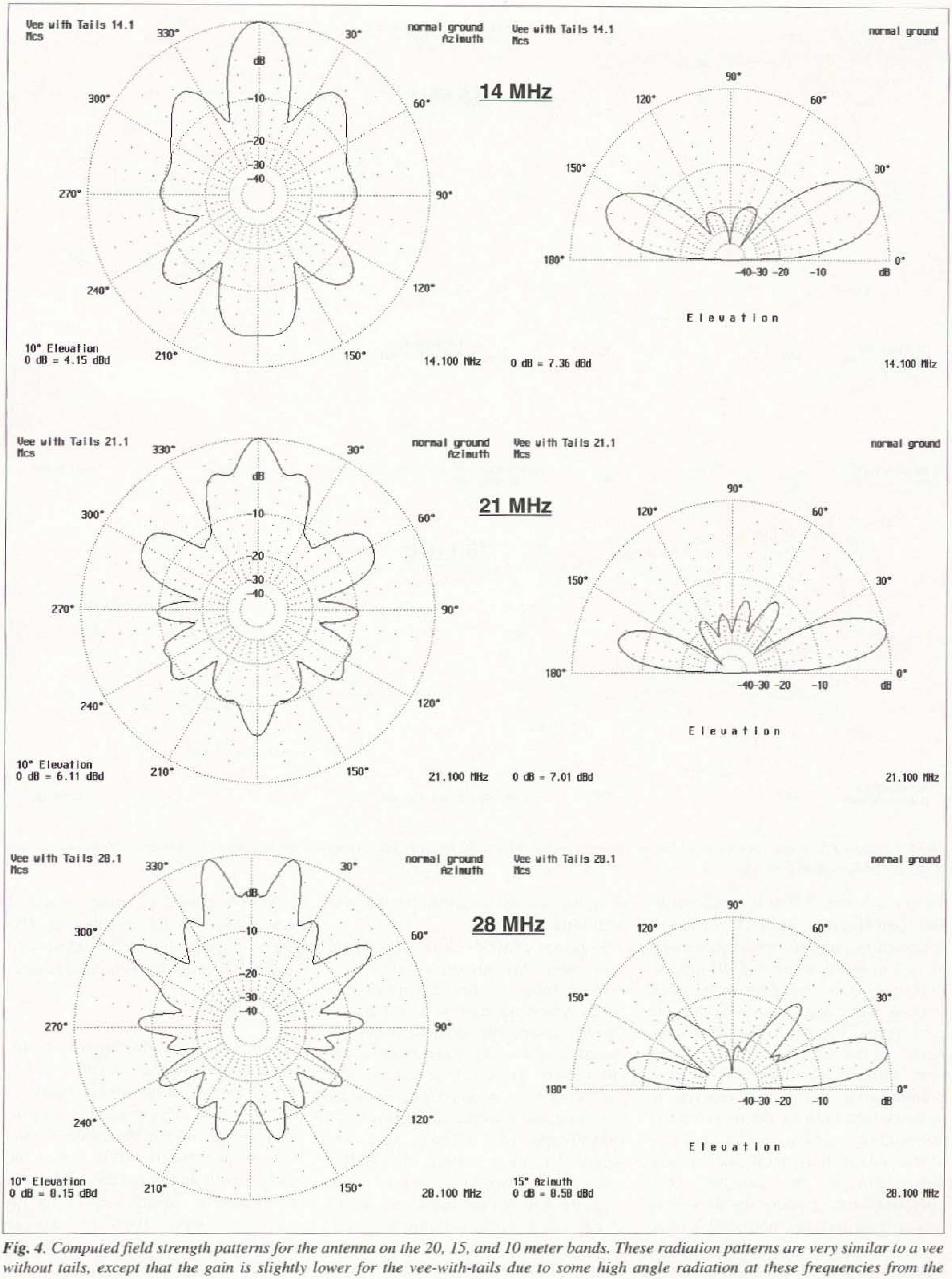


Fig. 4. Computed field strength patterns for the antenna on the 20, 15, and 10 meter bands. These radiation patterns are very similar to a vee without tails, except that the gain is slightly lower for the vee-with-tails due to some high angle radiation at these frequencies from the vertical radiators.

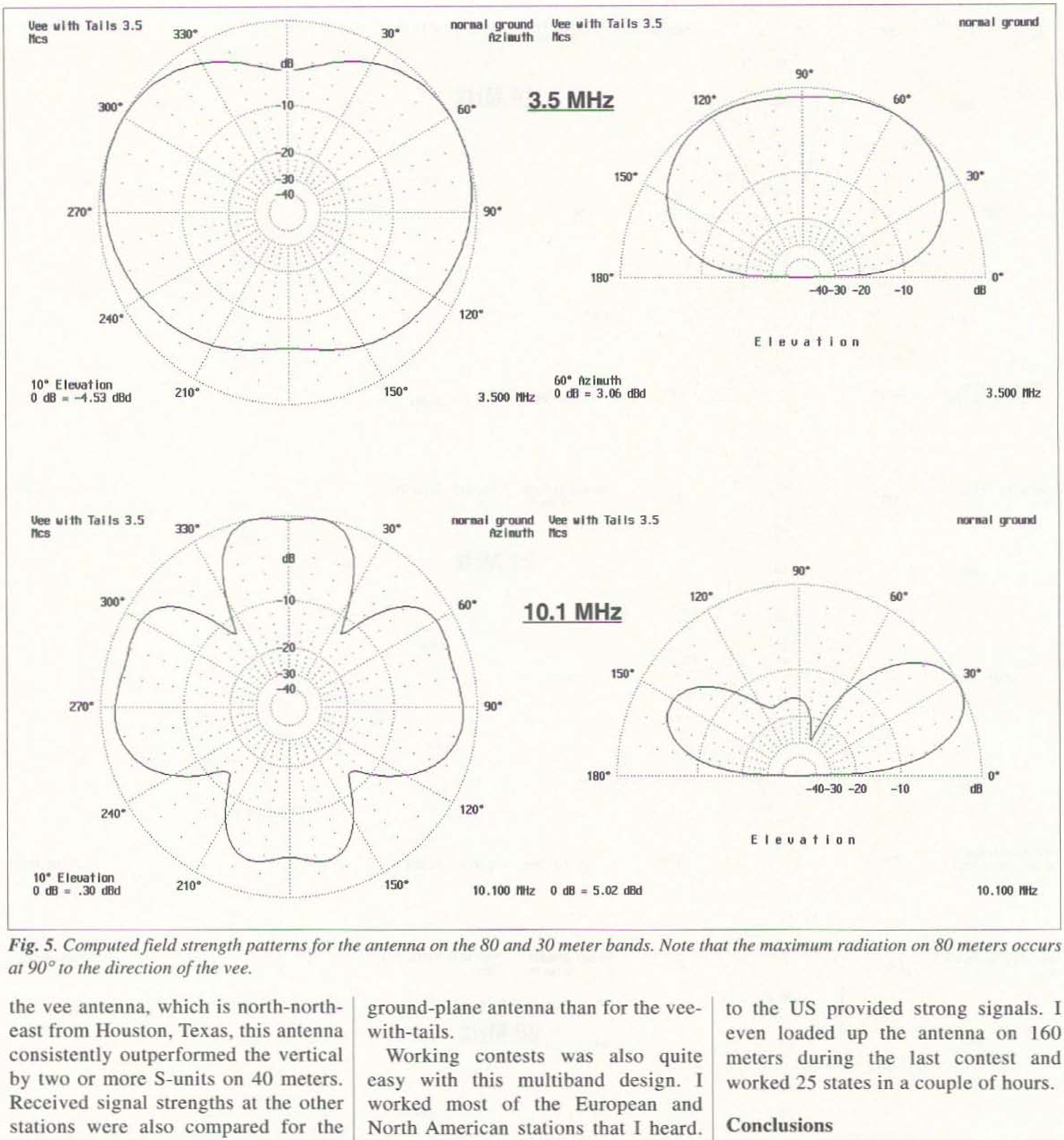


Fig. 5. Computed field strength patterns for the antenna on the 80 and 30 meter bands. Note that the maximum radiation on 80 meters occurs at 90° to the direction of the vee.

the vee antenna, which is north-northeast from Houston, Texas, this antenna consistently outperformed the vertical by two or more S-units on 40 meters. Received signal strengths at the other stations were also compared for the vertical and the vee beam with tails. Again, in the direction of the vee, the beam with tails performed two or more S-units better. Fading was reported to be much less, both for the received and transmitted signals, partly because of the mixed horizontal and vertical polarization of the antenna. QRP operation with 2 watts on 40 meters was a snap into the northeast United States and Mexico, with 579 signals. Signal strengths at 90° to the orientation of the vee were better for the ground-plane antenna than for the vee-with-tails.

Working contests was also quite easy with this multiband design. I worked most of the European and North American stations that I heard. On 20 meters, the antenna could not compare to the big yagi antennas on tall towers. However, it consistently put out a very strong signal into the northeast and Europe, comparable to a triband-type yagi antenna at a low height. During a couple of contests, when the 15m band was open to Europe, the antenna put out a very strong signal. On 80m the maximum vertical radiation is 90° from the direction of the vee. South American contacts were 579 with 100 watts, while short-skips to the US provided strong signals. I even loaded up the antenna on 160 meters during the last contest and worked 25 states in a couple of hours.

Conclusions

Considering that this antenna is designed for multiband operation and is only 35 feet off the ground, it works remarkably well. The antenna is easy to build and the tails can be adjusted for the best compromise in SWR across the bands. I built and tested this antenna in one afternoon with the help of my 10-year-old son, Ethan. The 9 to 1 balun can be replaced with an antenna tuner if desired. It is also possible to place a 16 to 1 ratio balun at the feed point and run 50 ohm coax to the tuner. A 16 to 1 balun provides a better match overall if the 450 ohm ladder line is not used.

The only critical parameter in the antenna design is the angle of the vee; that's what determines the radiation pattern at different frequencies. The shorter the horizontal length of the antenna, the greater the included angle in the vee should be. As an example, the G5RV version of the vee beam with tails has 51-foot horizontal wires with 34-foot vertical wires, and an included angle of 120°. This design works quite well on 40 and 80 meters and provides some low-angle of radiation that is not available from a conventional G5RV oriented in the horizontal direction.

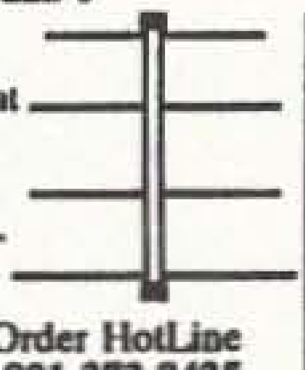
The vee is very simple to construct if you have some trees in your back yard. There are several variations of the lengths and angles for this antenna which can accommodate different sized lots. The critical thing in the construction is to keep the two sides of the vee the same length. And, since wire antennas are more susceptible to damage, record the SWRs on all the bands for future reference. This way, if you suspect some damage you can easily check it with an SWR measurement.

I've had a lot of fun with this antenna, especially since it is concealed among my trees and the neighbors don't even know that it exists.

References

1. *The ARRL Antenna Handbook*, 1995

2. AO and NEC programs published by Brian Beezley K6STI.



Build the QUAD-12

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Data Acquisition

The science of data acquisition is a subject in itself, but we can cover the basics in a few words. In digital data acquisition, you need to be most aware of what **NOT** to do.

1. *Don't damage your instrument.* Never apply a voltage greater than the A-D chip can resolve. In this case 4.096 VDC. The chip can actually handle greater voltages, but it's always a good practice to stay within design limits.

2. *Don't forget the Nyquist theorem.* Set the sample interval to least twice the highest frequency you expect to see. If you don't, you may be sampling only peaks or valleys.

3. *Don't lose data.* Write data only to a RAM disk or hard drive. Floppy drives are slow and you may miss a record or ruin your time base during disk writes. Floppy drives should be fast enough for sample intervals greater than 3 seconds.

4. *Don't let unused input pins float.* Connect unused channels to ground. Generally speaking, high input impedance is a good thing because the measurement system doesn't load the system under test. An open channel is measuring the electrical potential of the air, with respect to the ground plane of the computer. It's possible for high voltage on an open channel to affect an adjacent in-use channel.